JOSLIN (B.F.)

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ON

VISION.

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OBSERVATIONS ON VISION.

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ACCOMMODATION of the Eye to different distances.—When the pupil of one of my eyes was dilated by stramonium for certain physiological experiments, (an account of which will be published hereafter,) some indistinctness of vision was experienced, which was found on examination to affect objects at moderate distances only. All objects in the room were somewhat obscure, whilst those situated without, at the distance of many rods, appeared equally distinct to both eyes. By placing in contact with the eye, and directly before the dilated pupil, an opaque plate, perforated with a *circular aperture of nearly the same apparent magnitude* as the other pupil, there was no appreciable difference in the distinctness* of vision with the two eyes at any distance. It was, however, found necessary to employ different apertures for different distances, not only when the object was near the distance of distinct vision for minute objects, but at distances of many feet. The less the distance, the less was the requisite aperture; so that by employing artificial diaphragms of different apertures, the same distinctness of vision was obtained as with the eye in its natural state. This, however, was of course only true of direct vision; for in oblique vision, the lateral and too oblique rays of the pencil would not be thus excluded, and no artificial substitute can in that case be provided for the natural interior diaphragm, the iris, so happily imitated in the periscopic glasses of Dr. Wollaston. It is also probable that even in the case of very distant objects, there was a greater spherical aberration in the eye whose pupil was dilated, but that this was sensibly compensated by the stronger illumination resulting from a greater aperture.

We are warranted in concluding from the foregoing experiments, that at least under some circumstances, there is a necessary correspondence between the virtual magnitude of the pupil, and the accommodation of the eye to distinct vision at different distances—and also that the observed effect of the stramonium did not depend chiefly, if at all, on the paralysis of any other part concerned in the adaptation. Whether any change in the iris generally conduces to, or even at-

* The incident and emergent rays undergo a similar refraction at the cornea.

tends this accommodation in ordinary vision, is a point upon which physiologists are not agreed. The foregoing experiment seems to favour the affirmative.

Notwithstanding the various unsatisfactory conjectures respecting the uses of the ciliary processes, and the no less numerous hypotheses respecting the adjustment of the eye to distinct vision, this last has perhaps never been attributed to a change of *form* in the crystalline, produced by the *simultaneous* action of the different parts of the ciliary processes. An action producing lateral displacement has been supposed, which can effect no such adjustment, and is less likely to take place than a *general* contraction and dilatation, especially if we consider them as belonging to the erectile tissue.

In the eyes of a horse killed in health, and examined immediately after death, I found the attachment of these processes to the capsule of the crystalline very strong. It appeared to require more than ten times as much force to detach one of them, as to break an equal portion of the fibres of the crystalline, on whose contraction Dr. YOUNG supposed the adjustment to depend. In the human eye, however, the attachment is generally considered rather weak. It is perhaps strong enough during life to produce some little effect, and it is not necessary to suppose the accommodation to depend exclusively on any *single* structure, nor that the different parts of the eye which may conspire to produce this effect, exercise the *same relative influence* in different animals. The *stronger attachment* of the ciliary zone in some animals, *may indicate*, if not a different office, at least, a *greater share* in an office or function *performed by the combined action of several parts*, and by a different mechanism. I would hardly offer the above as a hypothesis, but merely state it for the consideration of physiologists.

But whatever hypothesis may be correct, it appears to me that the necessity of some adjustment has never been disproved, either experimentally or theoretically. It is true, that eminent physiologist, M. MAJENDIE, found the image formed on the posterior part of the dead eye of an animal to be distinct, when the object was placed at different distances; and this experiment has been considered irreconcileable with any theory of adaptation. But unless the angular magnitude of the object were very considerable, the image would be too minute to allow the irregularity to be perceived in such an experiment. For in this instance, the image which occasions our perception is the image of an image, and has nearly the same ratio to the primary image as the latter has to the object; so that it appears to me very possible, that the distinctness of the object might be sen-

sibly affected by a change of distance, such as would not sensibly affect the regularity of its image formed at the bottom of a dead eye, and regarded as an *object* of vision.

Theoretical arguments against accommodation are no less inconclusive. They have, so far as I have seen, overlooked the necessity of concentrating, upon a single point of the retina, the rays emanating from a single point of the object, and the constancy of their angles necessary for this effect. The difficulty is not removed, as has been supposed, by calling the eye a camera obscura; for this instrument also, when provided with a lens, requires adjustment to distance; and the reason why it may seem to "show objects distinctly for many miles round,"* appears to me to be, that at great distances, a given difference of distance produces a less difference in the obliquity of the rays, than an equal difference of distance in near objects. With objects at small distances, the defect would become instantly manifest. But on the other hand, adjust the instrument to near objects, and it would be of no avail that "an infinity of other rays flow from a distant object in all directions,"* unless those which flow from a single point, make with each other and with the cornea the same mean angles as those from a single point of a near object—which is impossible.

Moreover, the removal of a portion of the humours of the eye, or of the iris, dilates the image, by preventing the concentration of any pencil on a single point of the retina. The same effect is produced by any change in the requisite length of the axis. Hence the great extent of the vitreous humour is not only of "use to extend the field of vision,"* but is indispensable to the removal of the sentient screen to the precise distance at which the image is most perfect. This is a point which is not sufficiently appreciated by many physiologists, who speak vaguely also of the other humours, as merely "increasing the intensity of the light."*

In short, any change in the distance of the object, the refracting power of the eye, or the length of its axis, must produce a change in distinctness, unless a simultaneous change in two or more of these circumstances effects a compensation.

Now, different single parts, which by various physiologists and philosophers have been shown to effect this compensation, have by others been respectively either removed or placed in circumstances which nullified their influence, and yet the powers of compensation remained. These apparently contradictory results are reconciled by,

* See M. Majendie's Physiology.

and seem to require a less simple hypothesis. Such an hypothesis would be perfectly consistent with the rule of philosophizing, causas rerum naturalium non plures admitti debere, quam quæ et veræ sint, et earum phænomenis explicandis sufficiant; for more than one single cause has been proved to exist, yet no one of them has been proved fully adequate.

From some of the foregoing considerations, we might be induced to suspect that *night reading*, or any employment which requires the examination of minute and near objects with a faint light, and consequently during the expanded state of the pupil, has a tendency to produce myopia, or short-sightedness. For, during the obscurity of evening, the dilatation of the pupil necessarily resulting from the involuntary sympathy between the retina and iris is unfavourable to the distinct vision of near objects; but we nevertheless make an effort to see distinctly; an effort which may put in requisition to an extraordinary degree the voluntary powers of accommodation; and those parts in which these powers reside, and those upon which they directly operate may become permanently changed in their action and conformation, in consequence of a reïterated action in the former to a greater extent than is necessary during the light of day, when they enjoy in a higher degree the coöperation of the iris.

Appearance of the Tears on the Cornea.—Of all the proper objects of vision, (i. e. those exterior to the eye,) I have for many years believed that I had seen one of the nearest which could ever be visible to the eye of any animal; that is, the fluid secreted by the lachrymal gland, and rendered visible by the light refracted at its undulated surface, as it flows down the anterior surface of the cornea. This fluid contains visible spherical particles, or is mixed with some, partly perhaps from the meibomean glands. My experiments may be repeated in the following manner.

If any person, with his eyelids nearly closed, looks toward a window, or any luminous object nearly stationary, the luminous space will appear to be filled with circular bright spots, surrounded by dark rings. Some of these circles are much larger than others, and are either single, double, or multiple. An undulated appearance is frequently presented, each wave being either continuous, or composed of, or containing a chain of spherules. All these objects move slowly downwards in a vertical direction. That this motion depends on gravity, I assured myself, by giving to the head various inclinations, and finding the general direction of the motion still vertical as before. I say the general direction, for in whatever position the

head is placed, there are occasional instantaneous motions through very short spaces, such as would be produced by slight involuntary relative motions of the eyelid and eyeball, impressing on that part of the fluid contiguous to the tarsus, a motion which would be necessarily transmitted to the whole visible lamina, and produce in it a simultaneous displacement. That these slight motions are of this nature is verified by observation, for at any one time they agree in the instant of their commencement, in their direction, duration and extent, for all those objects of which we have been speaking. There are, however, other appearances which present themselves in the same field, but with which those just described, must not be confounded. They are less distinct points, with rapid and irregular motions, and resemble electric sparks. It is also necessary, in order to see no motions of the fluid on the cornea, except those which I have described, to guard the eye against voluntary motions, by directing the optic axis as steadily as possible toward some fixed point in space. With these precautions in making the observation, each visible portion of fluid will be seen finally to pass the inferior limit of the field of vision. This constant relation to the line of gravity in every position of the head, proves these objects to be some gravitating matter. The perpetuity of the phenomenon in the erect posture, forbids the supposition of its being in the humours; and the luminous centre and dark annulus of the circular spots, and the luminous middle and dark parallel sides of the linear ones, as well as the varieties in the appearance and number of the rings, (for more than one is frequently visible,) present the same appearances as perfectly transparent fluid spherules and waves on the surface of the cornea might produce, agreeably to the laws which regulate the transmission of light through thin plates of variable thickness.* Finally, these appearances are more obvious, when from weakness of the eye or any other cause, the lachrymal secretion is more abundant.

Hemiopsis.—I have twice experienced a partial insensibility of the retina, attended by some peculiarities not recorded in Dr. Wollaston's cases. At each time, objects and parts of objects, situated on the left side of the visual axis, were, for about half an hour, either indistinctly seen, or totally invisible; for instance, the left side of a printed page, of a line, and even of a single word, was not perceived whilst the eyes were directed to the middle. There was conse-

* From neglect of this principle, have not anatomists been sometimes deceived as to the structure of globules?

quently an insensibility of the right half of each retina. In both cases, a glimmering zig-zag, or broken line, appeared to be situated before the eyes above and to the left of the point toward which their axis were at any time directed, and as near as could be determined, in that part of the field of vision which was most completely obscured. In the first case, this line had an angular appearance, being composed of two lines, (see figure,) meeting at an angle of about 60°. It moved very slowly upwards, and to the left, and disappeared about the same time that perfect vision was restored. In the second case, the line resembled one of the branches of the former, was, like it, composed of numerous short lines, but its general course was nearly straight and horizontal. Its left extremity became gradually more and more elevated, and in this oblique position the imaginary object finally disappeared. The whole space occupied by these objects, subtended a visual angle of about 20°. Their coëxistence with the hemiopsis may be worth recording, as similar observations may possibly throw some light on the pathology of both. It is well known that Dr. Wollaston has inferred from the latter a semi-decussation of the optic nerves.

Schenectady, Dec. 1830.